



# **Enzymes**



# Essential Questions:

- What is the structure and function of an enzyme?
- What factors impact the rate of the enzyme reaction?

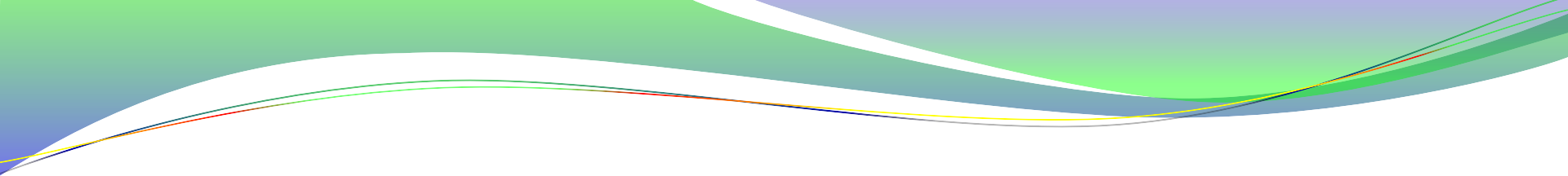


# Proteins

Combination of 20 different amino acids bonded together with a peptide bond

AKA-polypeptides.

Why? - Connected with many peptide bonds



**Chemical Reaction:** process that transforms one set of chemicals into another by changing the chemical bonds (mass and energy are conserved)

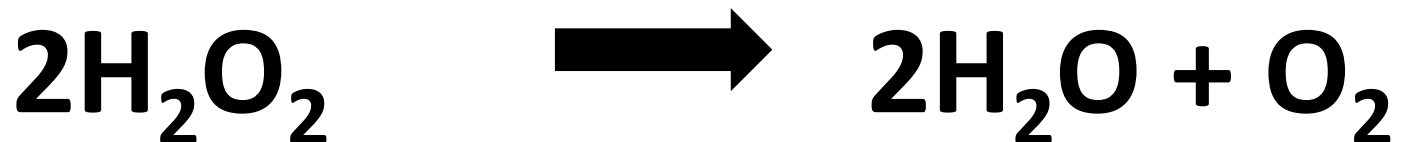
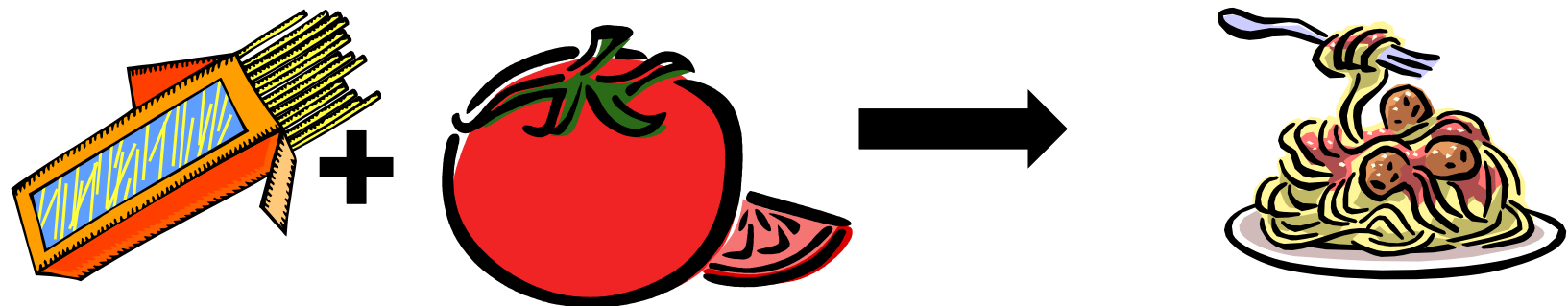
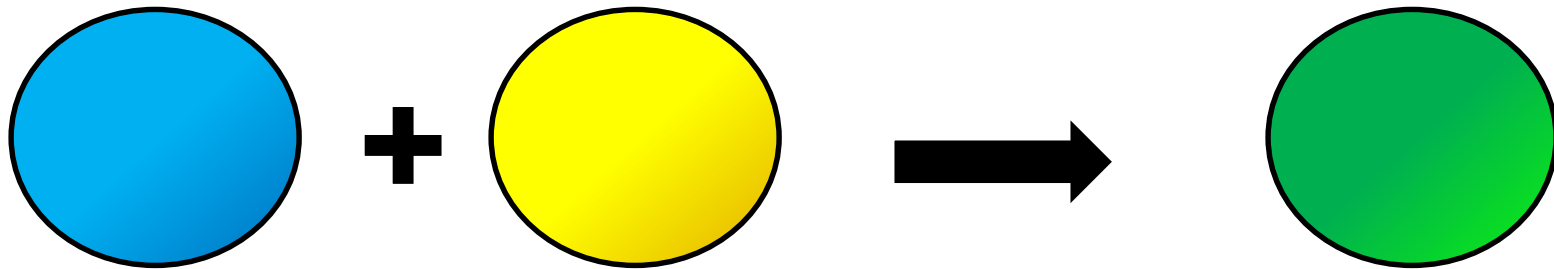
**Reactant:** starting material (substrate)

**Product:** Result from reaction

# Examples:

REACTANTS

PRODUCTS





# Types of Reactions

- Endothermic – reaction that absorbs energy
- Exothermic - reaction that releases energy, usually as heat.

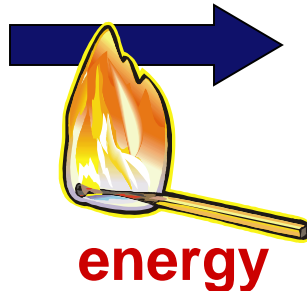
# Macromolecules

- large and stable
- Molecule must be broken down to be used by the body
- Must absorb energy to break bond

Can cells  
use heat to  
break the  
bonds?



**cellulose**



**energy**



**$\text{CO}_2 + \text{H}_2\text{O} + \text{heat}$**



# Activation Energy

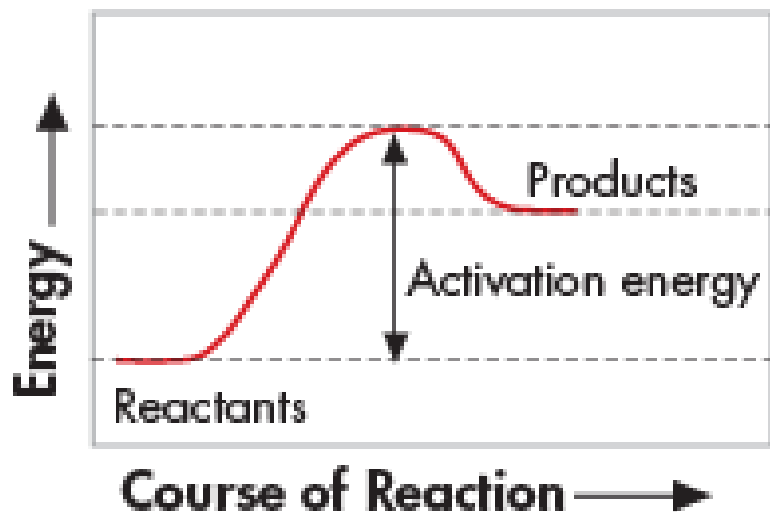
- **activation energy**: energy that is needed to get a reaction started



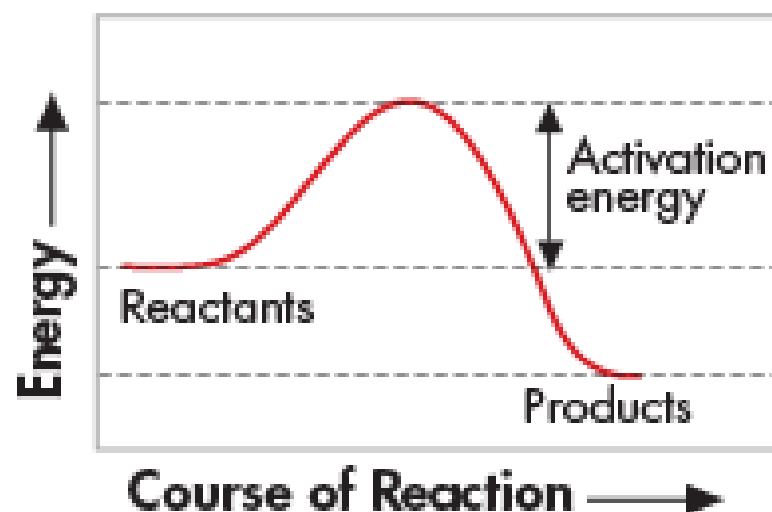
# Activation Energy

- The peak of each graph represents the energy needed for the reaction to go forward.
- The difference between the required energy and the energy of the reactants is the activation energy.

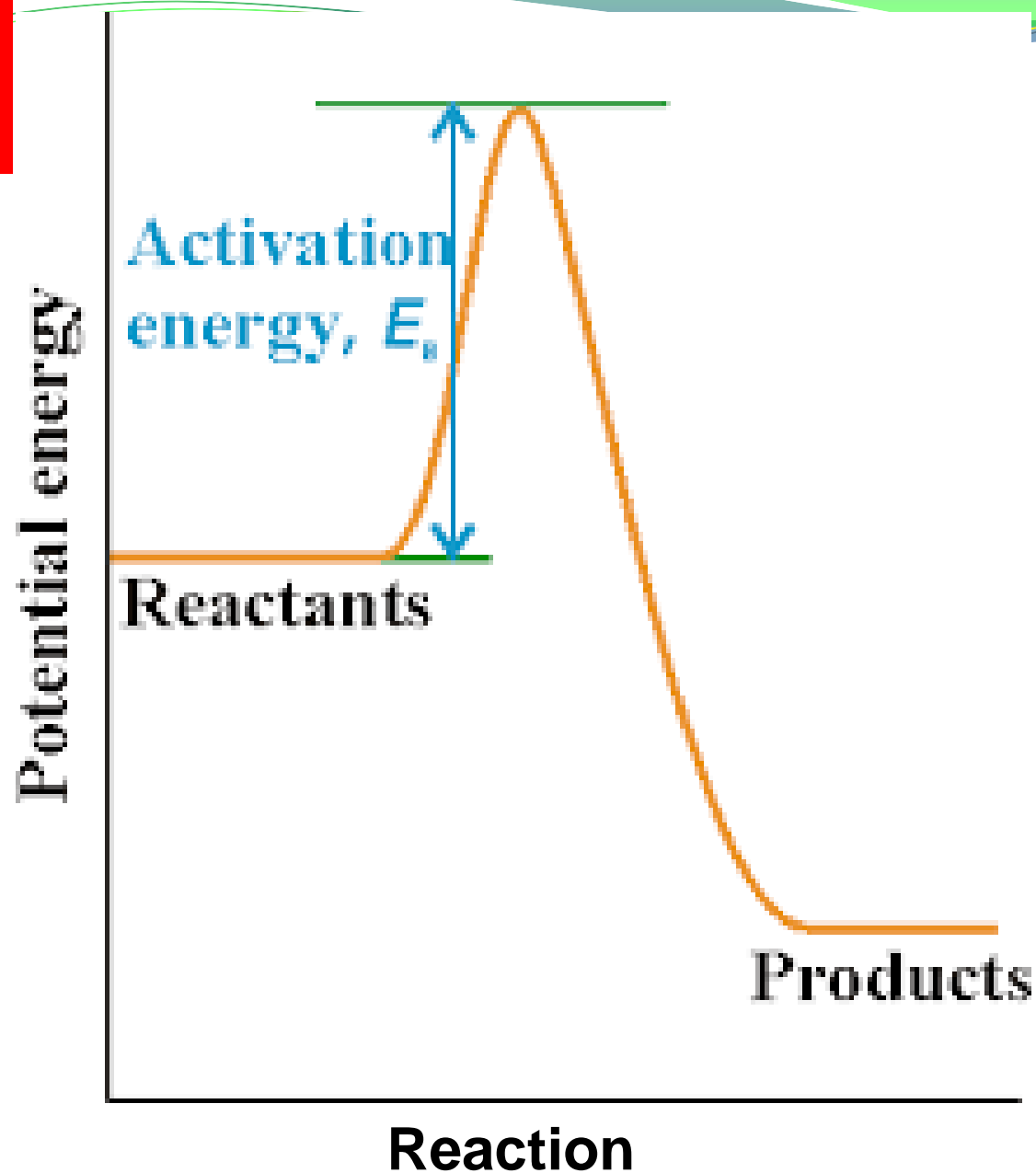
## Energy-Absorbing Reaction



## Energy-Releasing Reaction



# Label Graph



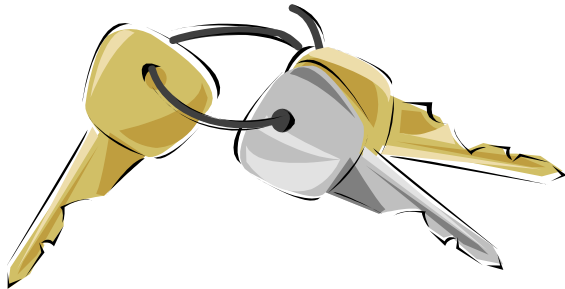
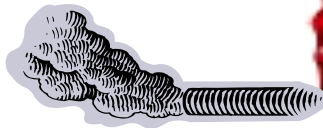
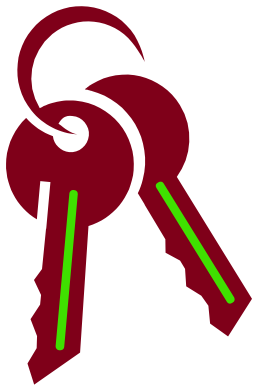
# Basic Definitions

**Catalyst:** Speeds up the rate of a reaction by lowering the activation energy

**Enzyme:** are proteins that act as biological catalysts

**Substrates:** reactants of enzyme-catalyzed reactions are known

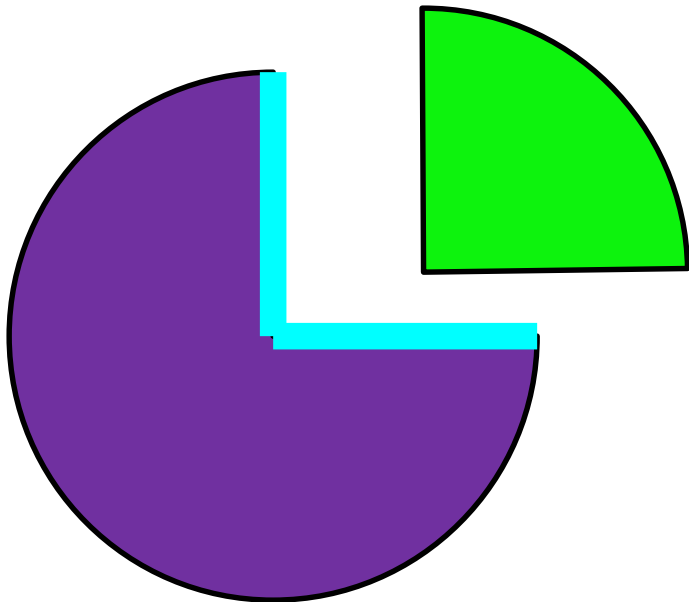
The Substrate must perfectly fit  
the Active Site of the Enzyme to  
work.



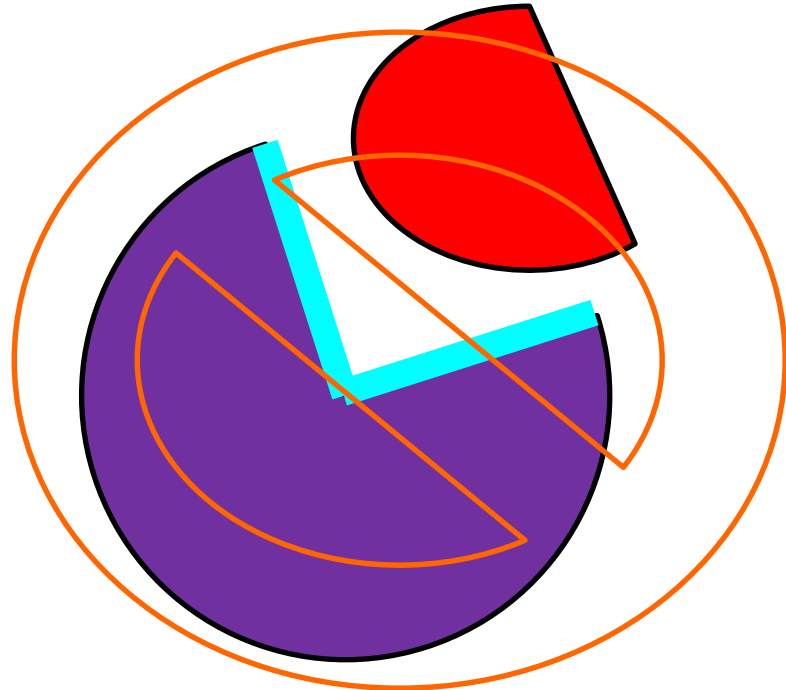
# How does an enzyme work?

- **ENZYME** has an **ACTIVATION SITE** that **SUBSTRATE** (reactant) must perfectly fit into.
- **Enzyme:** Lock; **Substrate:** Key

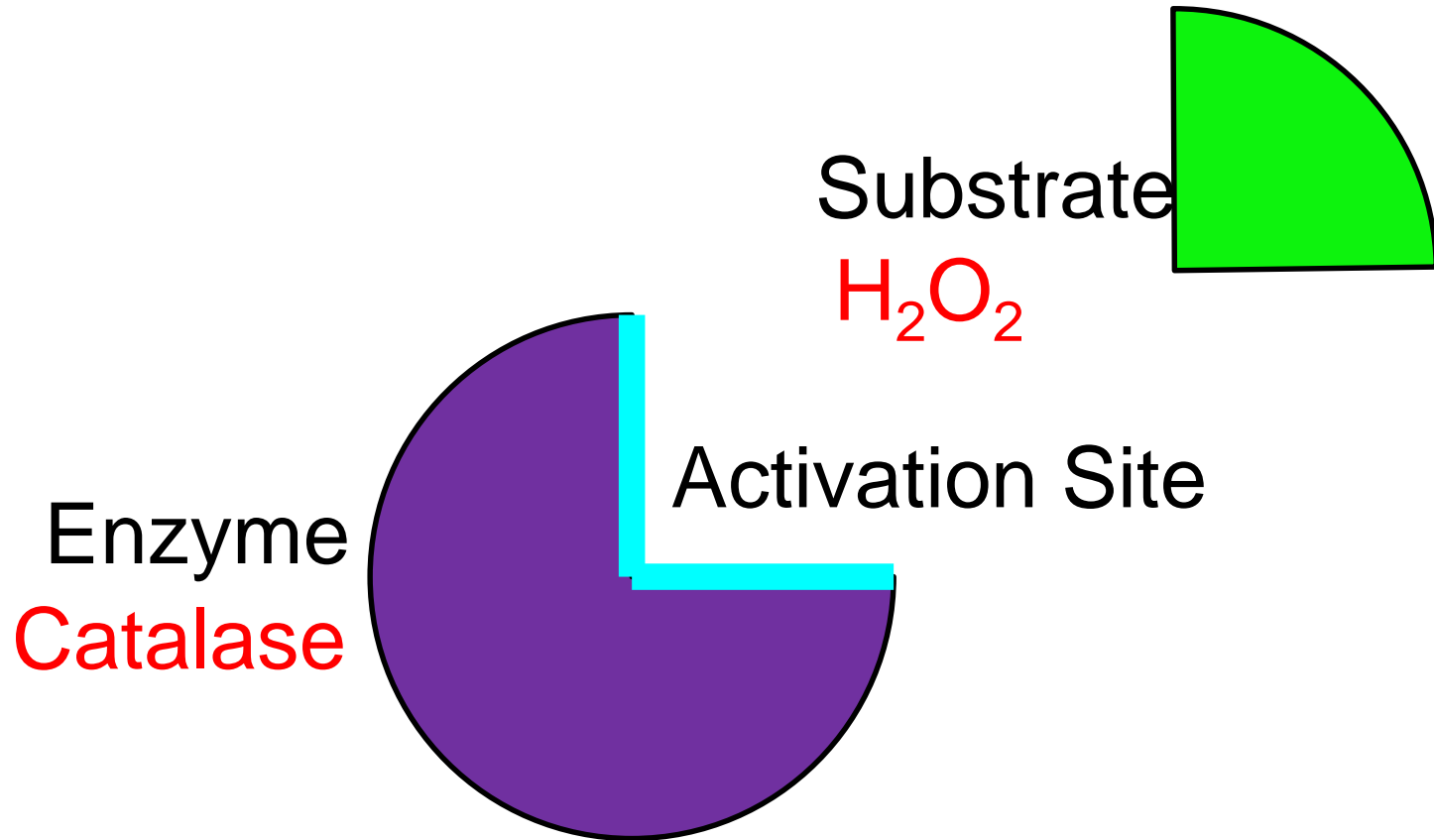
Example

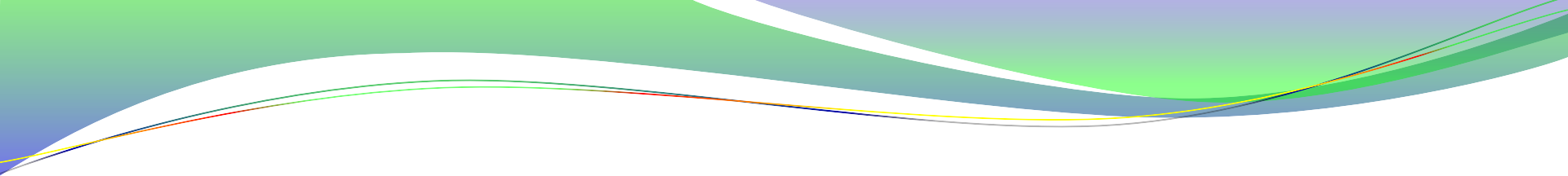


Non-Example

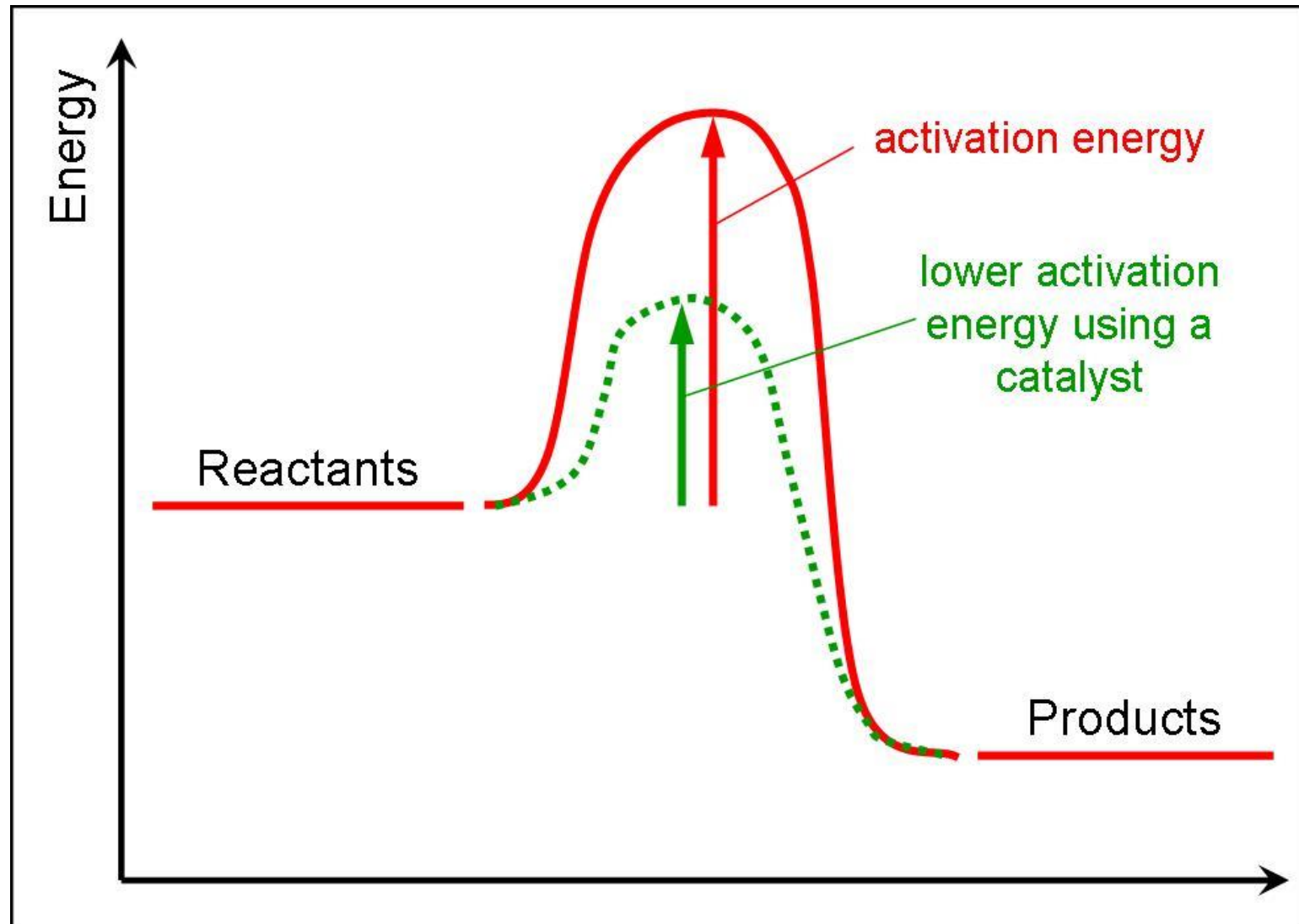


# Potato Lab



- 
- [http://highered.mheducation.com/sites/0072495855/student\\_view0/chapter2/animation\\_how\\_enzymes\\_work.html](http://highered.mheducation.com/sites/0072495855/student_view0/chapter2/animation_how_enzymes_work.html)

# Enzyme Lowering the Activation Energy ( $E_A$ )





# Naming Enzymes

Enzyme is specific to the substrate

1. Lipase breaks down lipids.
2. Protease breaks down proteins.
3. Amylase breaks down carbohydrates.

# Rate of a Reaction

<b>Time (min)</b>	<b>Sucrose Concentration (uM)</b>
<b>0</b>	<b>0</b>
<b>10</b>	<b>5.0</b>
<b>20</b>	<b>8.5</b>
<b>30</b>	<b>10.5</b>
<b>40</b>	<b>11.0</b>
<b>50</b>	<b>11.3</b>
<b>60</b>	<b>11.5</b>

- Rate of the reaction- speed of reaction

$$\text{Rate} = \frac{\Delta \text{concentration}}{\Delta \text{Time}}$$

# Example

$$\text{Rate} = \frac{\Delta \text{concentration}}{\Delta \text{Time}}$$

$$\text{Rate} = \frac{0 \text{ uM} - 10.5 \text{ uM}}{0 \text{ s} - 30 \text{ s}}$$

$$\text{Rate} = \frac{-10.5 \text{ uM}}{-30 \text{ s}}$$

$$\text{Rate} = 0.35 \text{ uM/s}$$

Time (min)	Sucrose Concentration (uM)
0	0
10	5.0
20	8.5
30	10.5
40	11.0
50	11.3
60	11.5

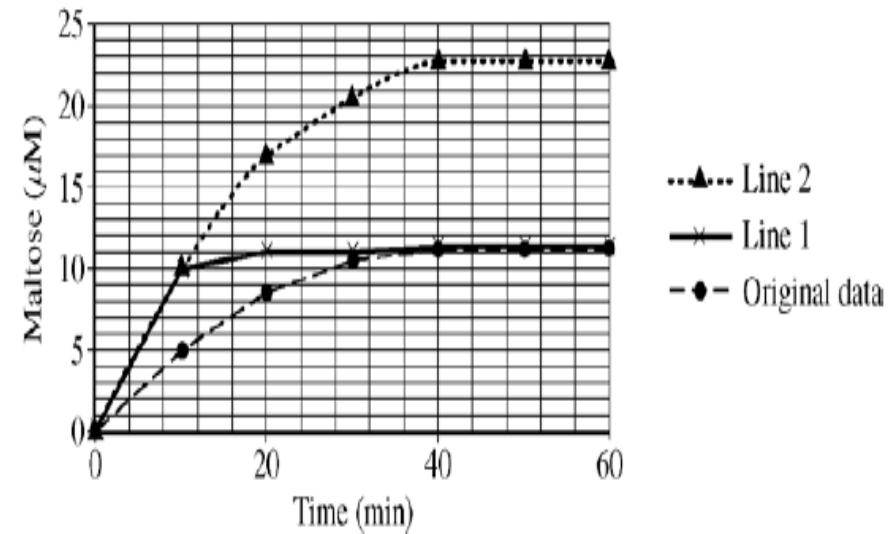


# Facts that impact Rate

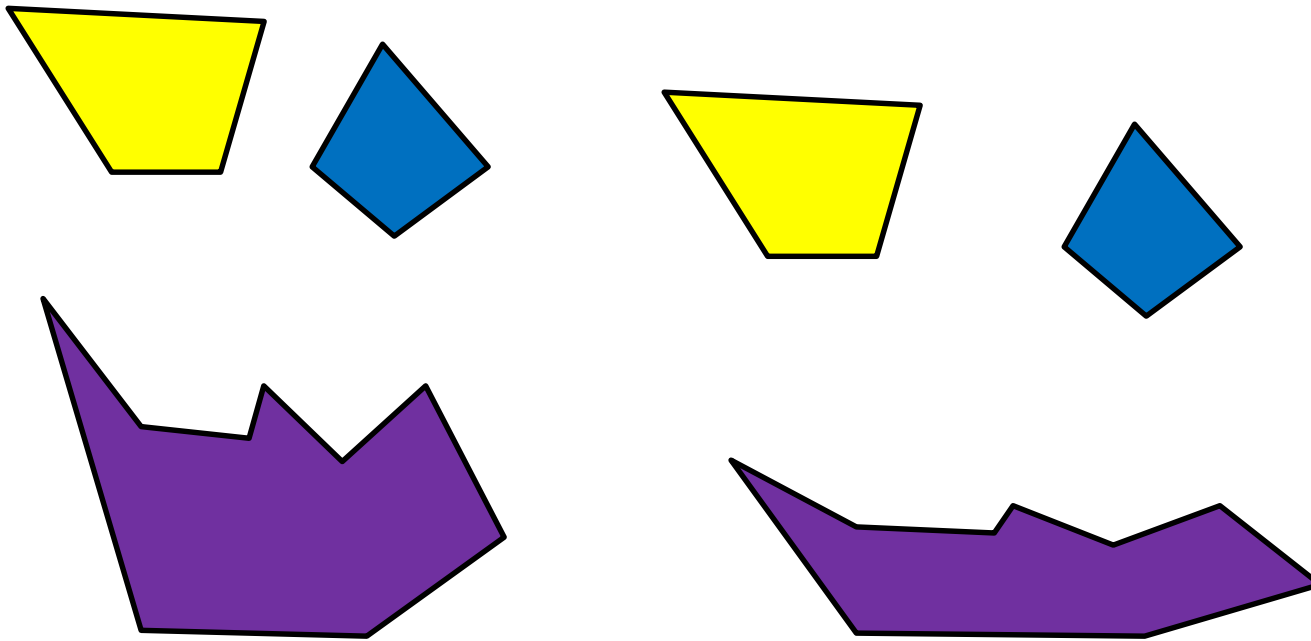
- Concentration
- Temperature
- pH
- Salinity
- Inhibitors
- Stir/mixing
- Pressure

# Increase Concentration:

- Increasing **Substrate Concentration** increases the rate of reaction.
- more **substrate** molecules will be colliding with **enzyme** molecules, so more product will be formed.



- **Denaturing**: changing the enzyme shape, making it useless.

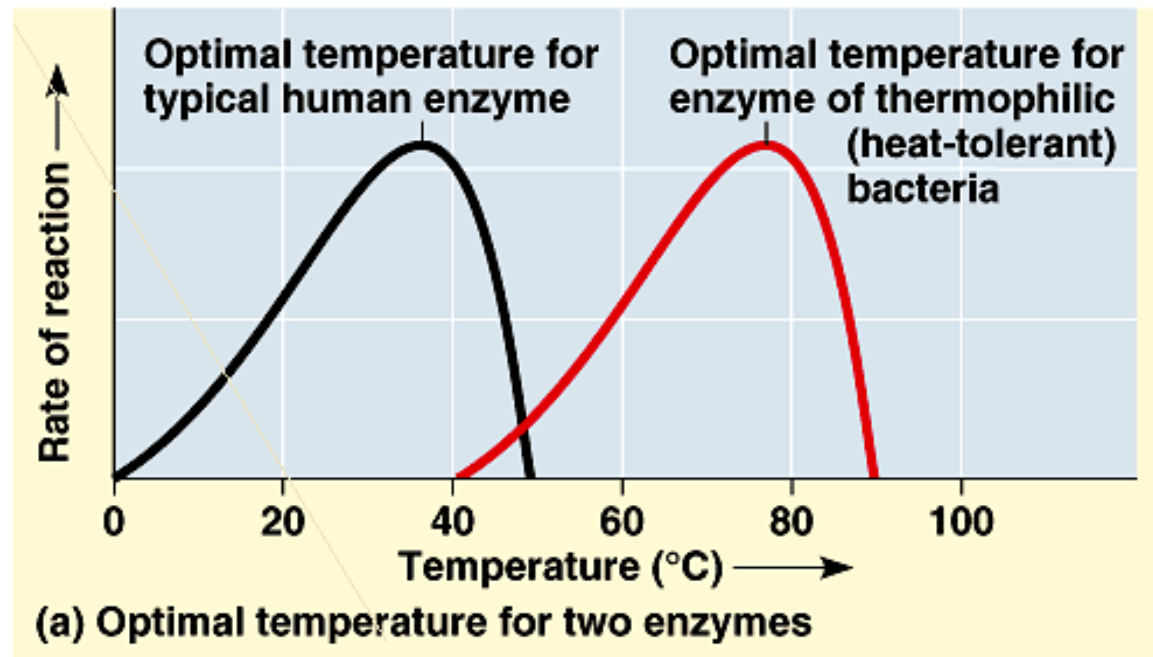


**NORMAL SHAPE**

**DENATURED SHAPE**

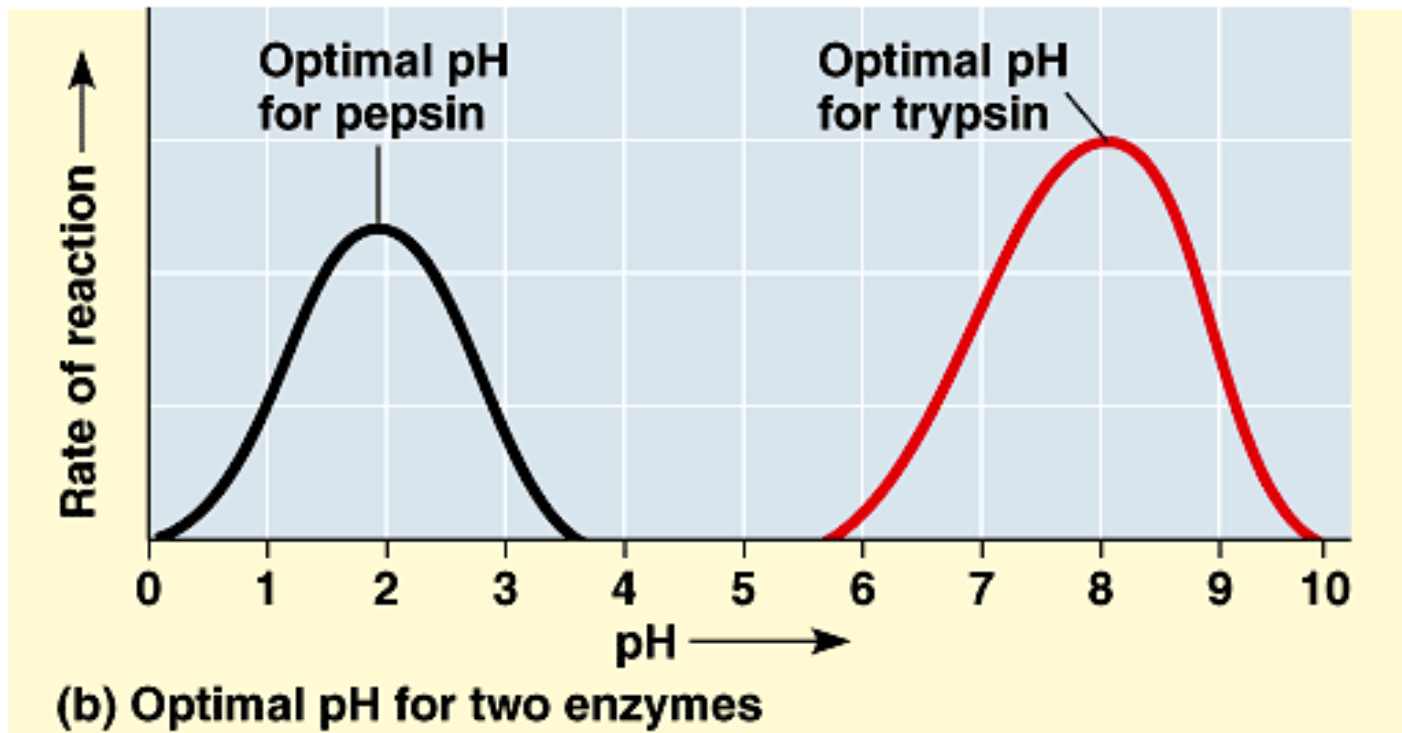
# Temperature

- Increase temperature, rate increase
- Decrease temperature, decrease rate
- Too much heat denatures enzyme



# pH

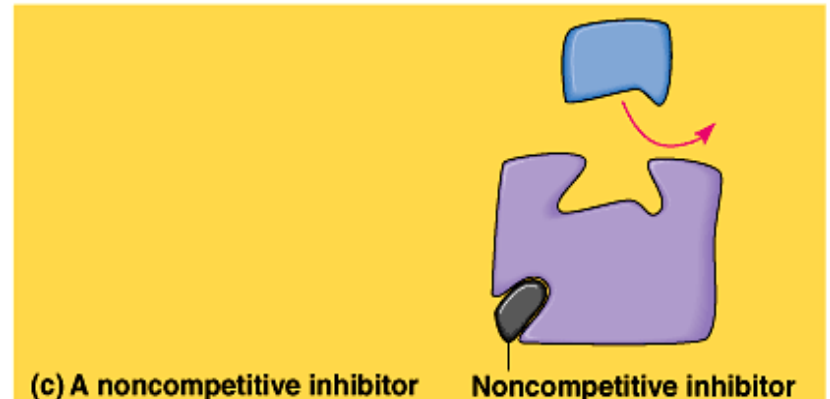
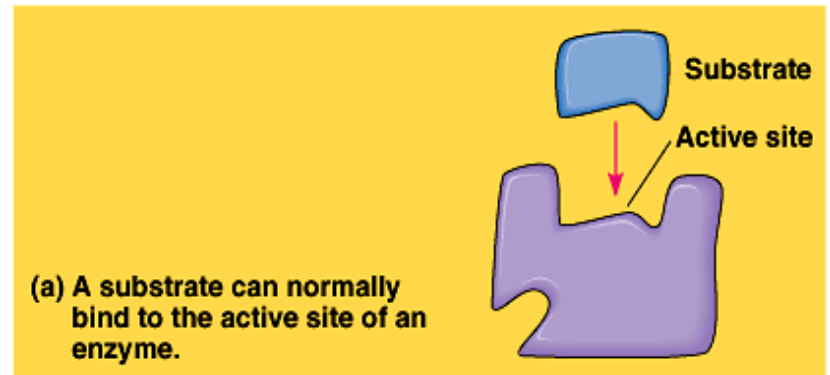
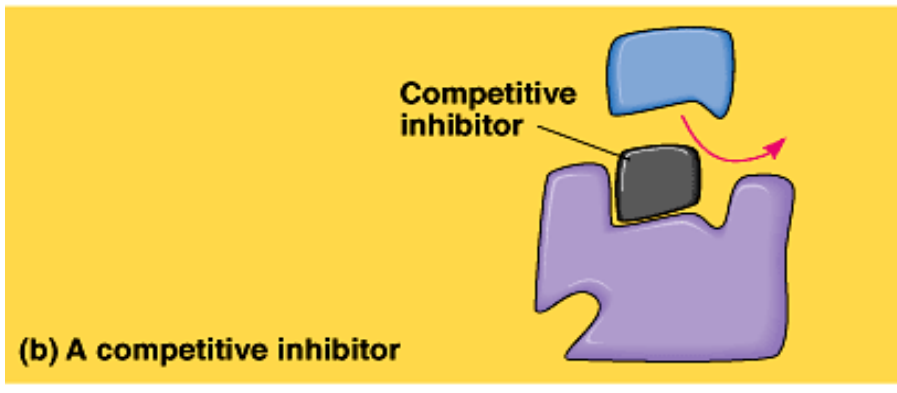
- Optimal pH varies based on enzyme
- Changes can denatures enzyme





# Inhibitors

- chemicals inhibit the action of an enzyme.





# Other Factors

- Salinity – denatures enzyme
- Stir/mixing – increase mixing  
increase rate
- Pressure – increase pressure  
increase rate



# Summary

- Answer the following 2 questions based on the notes.
  - What is the structure and function of an enzyme?
  - What factors impact the rate of the enzyme reaction?